Biomass Research and Development

Technical Advisory Committee

November 21–22, 2013

Meeting Summary

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List of Acronyms

ASTM – American Society for Testing and Materials
AUD – advanced uniform design
BER – Biological and Environmental Research
Biomass Act – Biomass Research and Development Act of 2000
BLM – Bureau of Land Management
BRC – Biomass Research Center
BRDI – Biomass Research and Development Initiative
CAAFI – Commercial Aviation Alternative Fuels Initiative
CLEEN – Continuous Lower Energy, Emission and Noise
Committee – Biomass R&D Technical Advisory Committee
D&D – Demonstration and Deployment
DOE – Department of Energy
DOI – Department of the Interior
DOT – Department of Transpiration
DPA – Defense Production Act
EISA – Energy Independence and Security Act of 2007
EMSL – Environmental Molecular Sciences Laboratory
EPA – Environmental Protection Agency
F2F2 – Farm to Fly 2.0
FAA – Federal Aviation Administration
FCEA – Food, Conservation, and Energy Act of 2008
FOA – Funding Opportunity Announcement
GGE – gallon of gasoline equivalent
GREET – Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation
GW – gigawatt
IBRs – integrated biorefineries
JGI – Joint Genome Institute
MOU – Memorandum of Understanding
NEPA – National Environmental Policy Act
NIFA – National Institute of Food and Agriculture
NSF – National Science Foundation
REAP – Rural Energy for America Program
RFI – Request for Information
USDA – U.S. Department of Agriculture
USN – U.S. Navy

I. Purpose

On November 21–22, 2013, the Biomass Research and Development Technical Advisory Committee (the Committee) held its fourth quarterly meeting of 2013. The Committee received updates about the U.S. Department of Energy's (DOE's) Bioenergy Technologies Office (BETO), and a U.S. Department of Agriculture (USDA) representative delivered presentations about current agency activities. The Committee was introduced to the new BETO director and provided with an overview of the BETO 2013 Peer Review findings. There was also a panel on the use of marginal lands for biomass.

See Attachment A for a list of meeting attendees. See Attachment B to review the meeting agenda. Meeting presentations can be viewed on the Biomass Research and Development Initiative website: http://biomassboard.gov/committee/meetings.html.

Background: The Committee was established by the Biomass Research and Development Act of 2000 (Biomass Act), which was repealed and replaced by Section 9008 of the Food, Conservation, and Energy Act of 2008. The Biomass Research and Development Board (the Board) was established under the same legislation to coordinate activities across federal agencies. The American Taxpayer Relief Act of 2012, Title VII—Extension of Agricultural Programs, Sec. 701. "1-Year Extension of Agricultural Programs," subsection (f) Energy Programs, Paragraph 7 on "Biomass Research and Development" extended Section 9008 through 2013. The Committee is tasked with advising the Secretary of Energy and the Secretary of Agriculture on the direction of biomass research and development (R&D).

II. Welcome

Ronnie Musgrove, Committee Co-Chair
Kevin Kephart, Committee Co-Chair

Mr. Musgrove and Mr. Kephart welcomed the Committee to the fourth meeting of the year and called the meeting to order.

III. Committee Business for 2013 and U.S. Deparment of Energy Updates

Elliott Levine, U.S. Department of Energy, Designated Federal Official

Mr. Levine provided the Committee with some overview and background information. Mr. Levine then provided an update on recent BETO activities. Mr. Levine announced that the following Committee members are no longer eligible to serve on the Committee or be elected to a second term:

- Committee Co-Chair: Ronnie Musgrove, Former Governor of Mississippi
- Huey-Min Hwang, Professor, Department of Biology, Jackson State University
- Neal Gutterson, President and Chief Executive Officer, Mendel Biotechnology
- Jay Levenstein, Deputy Commissioner, Florida Department of Agriculture and Consumer Services

Mr. Levine updated the Committee on the recent reorganization of DOE's Office of Energy Efficiency and Renewable Energy, which places BETO in the Office of Transportation, along with the Vehicle Technologies Office and Fuel Cell Technologies Office.

Mr. Levine announced the two active BETO requests for information (RFI). They are as follows:

- Demonstration and Deployment Strategies
    - Announced: November 5, 2013
    - Closed: December 6, 2013
    - Description: BETO seeks stakeholder feedback regarding bioenergy technology validation to accelerate the deployment of advanced biofuel, bioproducts, and biopower technologies. BETO is specifically interested in technologies that are ready for technology validation at a technology readiness level of 6 or higher.
- Carbon Fiber
    - Announced: August 21, 2013
    - Closed: September 6, 2013
    - Description: BETO has issued a RFI on the need for federal financial assistance to research, develop, demonstrate, and deploy emerging renewable carbon fiber technologies.

Mr. Levine shared the results and recommendation from the Inspector General's Report on the Integrated Biorefinery Projects. He also passed along updates from the DOE Office of Science on the USDA-DOE Joint Plant Feedstock Genomics for Bioenergy research solicitation, including funding opportunity announcements (FOAs) expected in November and December 2013, as well as recent awards made.

Finally, Mr. Levine updated the Committee on recent staff changes in BETO, including the arrival of the new BETO director, Jonathan Male.

IV. Introduction of New Bioenergy Technologies Office Director

Dr. Jonathan Male, Director, Bioenergy Technologies Office, U.S. Department of Energy

Dr. Jonathan Male, the new BETO director, gave a brief overview of his background and outlined his plans for the direction of the Office moving forward. Dr. Male has a Ph.D. in Chemistry from Simon Fraser University, and a B.Sc. in Applied Chemistry from the University of Greenwich~~, and an Executive M.B.A. from the State University of New York at Albany~~. Professionally, he has worked at Pacific Northwest National Laboratory and the GE Global Research Center. His expertise includes development and execution of research programs; R&D of catalysts (both homogeneous and heterogeneous); and development and implementation of high-throughput experimentation technologies.

As the new BETO director, he leads the overall strategic, project, and technical oversight of efforts to improve performance, lower costs, and accelerate market entry of advanced biofuels and bioproducts. He shared his intention to emphasize innovation through BETO's unique role in supporting the entire value chain and driving the innovations that will have meaningful national impact over the medium and long term. He identified three initial needs for BETO: (1) developing an expanded understanding of the supply chain, (2) developing innovation metrics, and (3) developing better messaging to communicate progress.

V. Results of the Bioenergy Technologies Office Peer Review

Dr. George Parks, President, FuelScience LLC
Dr. Jonathan Male, Director, Bioenergy Technologies Office, U.S. Department of Energy

Dr. Male provided an overview of the recent 2013 BETO Project Peer Review and Program Management Review. The Project Peer Review was a four-day event with seven breakout sessions and 450 attendees. The Program Management Review was a one-day event with one general session and 150 attendees. For the Peer Review, 219 projects were reviewed across nine technology areas, representing a DOE portfolio investment of $1.6 billion over the lifetime of the projects (approximately 86% of the BETO portfolio). Forty-two independent expert reviewers from industry, academia, and other government agencies conducted the review. Results of the Peer Review inform BETO strategic planning, budget formulation, upcoming FOA development, and other budget and funding decisions.

As part of the Peer Review, an External Steering Committee participated in the Peer Review process, which included the Project Peer Review and the Program Management Review. The External Steering Committee provided planning guidance, reviewer recommendations, and other inputs throughout the process and drafted the Steering Committee Final Report, which details overall feedback, strengths, weaknesses, gaps, and overall recommendations for the Office.

Dr. George Parks served as the de-facto Steering Committee Chairman and represented the perspective of the Steering Committee. Dr. Parks is President of FuelScience, LLC, and he previously spent more than 30 years at ConocoPhillips. The complete Steering Committee included the following members:

- James Dooley: Forest Concepts
- Kelly Ibsen: Lynx Engineering, LLC
- Steve Kelley: North Carolina State University
- Robert Mantz: Army Research Office
- Bob Miller: Air Products (retired)
- George Parks: ConocoPhillips (retired)
- Mark Yancey: Neatech, LLC.

Each Steering Committee member was assigned a technology area to oversee. The technology areas reviewed are as follows:

- Bio-Oil
- Gasification
- Feedstocks
- Biochemical
- Algae

- Analysis and Sustainability
- Integrated Biomass Refineries (IBRs).

Overall recommendations to the Office focused on the following:

- Develop stronger techno-economic analysis (TEA) and life-cycle analysis for all projects
- Continue to work toward replacing the whole barrel
- Understand regional impacts of feedstock quality
- Maintain the project pipeline from incubator projects through IBR pilot and demonstration projects
- Share data across the portfolio
- Conduct an Algae—50/50 Challenge for productivity and fuel yield
- Perform gasification research.

In response to the recommendations, Dr. Male provided updates on new and current BETO activities, addressing some of the comments from the Steering Committee at the November Technical Advisory Committee meeting. Dr. Male discussed how DOE is working to produce innovative new materials from biomass by utilizing sugars, lignin, and other biorefinery products to enhance industry economics.

Dr. Male stated that DOE is creating an Incubator Program with dedicated annual funding to support innovative technologies that are not represented in DOE's existing technology portfolio. DOE is also exploring opportunities to combine biomass with low-cost natural gas for the production of liquid fuels. In addition, new annual operating plans (AOPs) are being drafted to improve coordination between BETO and the DOE national laboratory projects. DOE is continuing efforts to develop TEA and refine common assumptions as they relate to technology platform harmonization and the technology pathways assessment.

Dr. Male mentioned an open RFI that BETO announced (closed December 2013) to capture stakeholder comments and help refine a potential Fiscal Year 2015 FOA. BETO is also currently developing best management practices for deployment, which will be disseminated through conferences and publications.

VI. U.S. Deparment of Agriculture Updates

Todd Campbell, U.S. Department of Agriculture

Mr. Campbell provided updates from USDA on the following topics:

- Biorefinery Assistance Program
    - The Sapphire Energy algae-to-crude oil project in New Mexico has paid off a $54.5 million loan guarantee; it has been in continuous operation since May 2012
    - The Freemont Community Digester is fully operational
    - INEOS Bio in Vero Beach, Florida, is producing cellulosic ethanol at commercial scale; the first ethanol shipments will be released in August.

- BioPreferred Program
    - Designated eight new biobased product categories for preferred federal procurement, including aircraft and boat cleaners; automotive care products; engine crankcase oil; gasoline fuel additives; metal cleaners and corrosion removers; microbial cleaning products; paint removers; and water turbine bearing oils
    - There are now 97 designated categories representing approximately 10,000 unique product types
    - Reopened the Web portal for companies to apply for the voluntary USDA Certified Biobased Product label
    - Nine-hundred individual products have received the USDA Certified Biobased Product label.

- Solicitation Update
    - Section 9002—open
    - Section 9003—expected to open the program in the near future
    - Section 9004—unfunded for 2013
    - Section 9005—contract application period closed
    - Section 9007—solicitation closed; state awards expected in the near future
    - Section 9008—unfunded for 2013
    - Section 9011—unfunded for 2013.

- Farm Bill Title IX Update
    - Mr. Campbell provided a side-by-side comparison on the House and Senate changes to the Farm Bill.

- Climate Change Adaptation/Mitigation
    - New threats have been observed in recent years: increased risk of severe wildfire, more intense storms, and problems from invasive pests. USDA announced the creation of seven new "regional climate hubs" to provide farmers/ranchers with regionally appropriate information to adapt to climate change.

VII. Use of Marginal Lands for Bioenergy

Solutions from the Land, Ernest Shea, Project Coordinator, Solutions from the Land Dialogue
Sustainable Bioenergy Production from Marginal Lands in the U.S. Midwest, Dr. Csar Izaurralde, Joint Global Change Research Institute

Ernest Shea, project coordinator from the Solutions from the Land Dialogue spoke first. He provided a quick overview of the 25x'25 Initiative. The 25x'25 Initiative's vision is for—by the year 2025—America's farms, ranches, and forests to provide 25% of the total energy consumed in the United States from renewable resources, while continuing to produce safe, abundant, and affordable food, feed, and fiber. As part of the Initiative, the University of Tennessee performed a study. The objectives were to determine the ability of America's farms, forests, and ranches to provide 25% of U.S. total energy needs in 2025 and assess the economic impacts of achieving the 25x’25 goal on the agriculture sector and the overall economy. The study results show that America’s farms, forests, and ranches can play a significant role in meeting the country’s energy needs. It also shows the 25x’25 goal can be met while continuing to provide safe, abundant, and affordable food, feed, and fiber.

The analysis operates under an assumption that the nation has underutilized forage lands. Therefore, a conservative assumption that an additional acre of hay land is required for every 2 acres of pastureland converted to dedicated energy crop production was added. Three states were reviewed. They showed it appears that the forage assumption (1 acre hay land for every 2 acres of pastureland converted to dedicated energy crops) used in the 2006 25x’25 study are conservative. There are areas where pasture land exists that if removed from forage supply will not impact the availability of forage and therefore beef production potential. A complete analysis needs to be conducted and an additional set of POLYSYS runs performed using this new information.

Next, Dr. Csar Izaurralde from the Joint Global Change Research Institute provided a summary of the Sustainable Bioenergy Production from Marginal Lands in the U.S. Midwest study. He began the talk defining marginal lands, or lands with low productivity (in the context of crop production) or use limitations (erodibility, salinity, water excess, etc.). Other terms used for marginal lands are unproductive, underutilized, idle, abandoned, or degraded lands. The benefits of marginal lands include a new source of revenue for farmers and other land owners; no food versus fuel conflict, as food production would not be displaced by fuel production; no indirect land-use effects; and no carbon debt from land conversion. He also introduced the Great Lakes Bioenergy Research Center (GLBRC), whose mission is to perform the basic research that generates technology to convert cellulosic biomass to ethanol and other advanced biofuels. The study provides analysis of long-term experimental data allowed for identification of treatments with best climate benefits. Spatial analysis conducted identified marginal lands based on land capability classification. The Environmental Policy Integrated Model (EPIC) was used to simulated cellulosic feedstock using perennial herbaceous vegetation on marginal lands across the U.S. Midwest, and geospatial analysis was conducted to identify potential location of cellulosic ethanol biorefineries. The study found that there could potentially be 35 biorefineries on marginal lands in the U.S. Midwest with a potential ethanol production of about 25% of the Energy Independence and Security Act of 2007 advanced biofuel target.

Additional work is being done by applying new resources to model biofuel production on marginal lands with the EPIC model, such as enhancing the capability to identify and model bioenergy crops on marginal lands using the USDA National Crop Commodity Productivity Index database. Work is also evaluating marginal land concepts such as the GLBRC Marginal Land Experiment, which has six sites—three in Michigan and three in Wisconsin. Experiments and simulations suggest significant potential of marginal lands for sustainable bioenergy production.

VIII. Subcommittee Breakout Summaries and Committee 2013 Recommendations

Problem Statement

The primary obstacle to producing advanced biofuels and bioproducts from cellulosic feedstocks is the lack of cost competitiveness when compared with petroleum's cost of production. This lack of cost competitiveness is the main reason for the lack of adoption by consumers.

The Grand Challenge

Replace fossil carbon with renewable carbon in transportation fuels and related products: Rapidly expand the emerging biofuels and bioproducts industries, achieving 30% penetration of biomass carbon into the U.S. transportation market by 2030 in a sustainable and cost-effective manner to create jobs, reduce greenhouse gas impacts, and enhance national security.

Additional outcomes will include the following:

- Enhanced economic development by increasing direct and indirect jobs from 152,000 in 2012 (Bio-ERA Report) to more than 1 million by 2022. By 2030, with 45 billion gallons of fuel made with renewable carbon introduced into the biofuel industry, the direct and indirect economic impact should exceed 5 million jobs. Incentives need to guide such developments to provide opportunities for disadvantaged and minority populations.
- A cost-effective energy supply that is synergistic with existing fossil-based markets.
- Enhanced economic, environment, and social sustainability.
- Improved national energy security and decreased dependence of national defense on foreign energy supplies.

Barriers to Rapid Adoption of Biobased Fuels and Products

There are three main barriers that restrict our ability to achieve the goals set forth in the Grand Challenge.

- First, biomass as the source of low-cost renewable carbon feedstock for conversion to fuels adds significant complexity for the agricultural industry.
- Second, conversion technologies for production of fuel from cellulosic feedstocks suffer from high energy requirements and low productivity (yield and rate of production), as well as high capital expenditures per gallon, which results in conversion technologies that are unable to achieve reinvestment economics.
- Third, lack of an updated distribution infrastructure and other market incentives directly impacts the adoption of the new fuel products by consumers.

A. Low-Cost Biomass and Renewable Carbon Feedstock for Conversion to Fuels

Widespread, sustainable, affordable, commercial-scale biomass feedstocks is the nation's first key enabler to achieving significant bioenergy and bioproducts production for the United States' "all-of-the-above" energy strategy, and it also supports the White House's "National Bioeconomy Blueprint." DOE's

2005 Billion-Ton Study and the recent 2011 update[1] provide sound evidence that production of significant quantities of feedstocks is feasible and can be sustainable. Nevertheless, a continuous increase of accessing and utilizing these feedstocks will transform American agriculture. To put this transformation into perspective, an annual use of 1 billion tons of biomass by 2030 represents the output of a new agricultural system that is 20% larger than the current 800 million tons of all annual agricultural products, including hay and pasture. Major hurdles to near-term use of such biomass quantities that impact production volume, cost, distribution, and adoption of the final product include the following:

- Concerns around sustainable (environmental, social, and economic) development.
    - Can the current agricultural system supply bioenergy feedstocks at scale without causing chronic market shocks for food, feed, and fiber production?
- Matching supply and demand of both feedstock and biobased products in a nascent industry requires robust and cost-effective conversion technologies.
    - Scale-up of production capability and utilization of biomass in products are linked to each other and to the technological ability and market incentive of fuel manufacturers to convert these feedstocks into products. This means that the new industry's conversion technology, as well as the market supply and demand for products, will limit expanded feedstock production. The consumer demand equation represents a "market-pull" incentive to manufacturers to conduct R&D for lower costs and thus develop a sustainable business model.
- Adoption in the farming community and response to economic opportunities.
    - To achieve grower acceptance, engagement, and production leading to supply chain maturity, applicable feedstocks will need similar support that is available for existing agricultural technologies in the areas of research and education, commercial enablement, and policy support programs. Examples include feedstock development; feedstock logistics and transportation infrastructure; grower acceptance, education, and extension; production risk mitigation; and sustainability.

Despite the perceived ample availability of biomass, the feedstock supply has costly detriments. Biomass has low density, is usually widely distributed, and has relatively low economic value. The low densities and widely distributed nature adds cost to harvest, collection, and transportation, and presents logistical challenges to entraining these feedstocks into the biofuels supply chain. Differences among species, phenotypes, and conditions during growth, harvest, and storage result in feedstocks with profound variability in cellulose, hemicelluloses, and lignin concentrations—all of which have a major impact on net energy use and productivity of conversion.

[1] U.S. Department of Energy. 2011. U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry. R.D. Perlack and B.J. Stokes (Leads), ORNL/TM-2011/224. Oak Ridge National Laboratory, Oak Ridge, TN. 227p.

Economic barriers, in addition to debate on policy frameworks—such as the Renewable Fuel Standard—and lack of confidence in a long-term stable policy for other bioproducts are restricting capital investment in new cellulosic conversion facilities. Therefore, it is necessary to demonstrate technology performance and the sustainable economics of the business model for renewable fuels to investors in order to justify capital investment in biorefineries. To ensure that biofuels have impact, it is critical to implement new enabling technologies that significantly reduce capital costs and operating expenses.

Potential Solutions**:**

1. Accelerate deployment of feedstock from existing, aggregated waste streams:
    - Agricultural, forestry, silviculture residues, and processing wastes
    - Livestock manure
    - Municipal solid waste (MSW)
    - Food industry and animal processing wastes
    - Oil derived from the corn ethanol industry
    - Industrial wastes.
2. Develop new farming systems to provide feedstocks sustainably from agriculture through adoption of technologies and best practices that maximize production on current acres. With current technologies under development, the corn seed industry fully expects to achieve a national average corn harvest of 300 bushels per acre by 2030. Increasing the harvest from existing acres could span agronomic solutions such as intercropping and dual cropping; new approaches to plant breeding; genetic engineering; and innovative land-use strategies, including algal farms. Farming systems that provide multiple harvests per growing season would maximize productivity on existing agricultural land and add many “virtual acres” for biomass production, effectively reducing the distributed nature of feedstock production.
3. Invest in research, innovation, technology, and infrastructural advances to enable distributed industries to evolve and become less distributed and more efficient. Despite increases in agricultural yields through conventional inputs such as fertilizer, and unconventional inputs through technology development, the greatest hurdle remaining is the logistics of delivering feedstocks to biorefineries. Creating a network of collection points within 10–20 miles of production fields would not be used for long-term storage, but would be used as sites for feedstock receiving, segregation, and pre-shipment processing. Feasibility of the collection-point model resides in the ability to provide value to the conversion industry through densification, pretreatment, or initial processing of feedstocks. Examples include pelleting, fiber expansion, gasification, or production of pyrolysis oil.
4. Create industry standards for feedstock composition and consistency. Creating feedstock collection and processing sites is the precursor to developing robust bioprocessing technologies that can accommodate the variability of feedstocks. All bioprocessing industries could greatly benefit from coordinated standardization of feedstock composition. As with other agricultural processing industries, you could develop feedstock consistency through technologies that process or blend a variety of feedstock sources.

B. Highly Productive Conversion Technologies that Demonstrate Reinvestment Economics

Biomass conversion plants require substantially higher capital expenditure per gallon capacity than starch/sugar ethanol plants or biodiesel plants because biomass processing is more complex and entails a greater number of unit operations than conventional biofuel facilities. The typical solution to high capital cost is to increase scale by building larger facilities. In the case of biomass processing plants and biorefineries, the costs of transporting biomass greater distances rises rapidly and can render any savings from reduced per gallon capital expenditures as unfeasible. Further, higher capital costs increase perceived project risk and reduce the likelihood of obtaining investment funding.

There is still a significant need for R&D in biofuels and bioproducts facilities. Priority should go to technology investments that can significantly reduce the capital and operating costs of advanced biofuels and biochemicals. This should include funding additional basic research, targeted research on specific elements of processes, and programs that address operational issues of early pilot and/or demonstration facilities.

Additional needs include development of technologies that have economics for early-stage plants that attract capital investment for subsequent expansion of similarly designed facilities. This targeted government investment in R&D and process optimization (in addition to stable and supportive policy) will enable the new industry to grow and prosper successfully.

Potential Solutions**:**

Discovery of solutions will require additional R&D in technology areas that allow significant reductions in the capital and operating costs of producing advanced biofuels and bioproducts. Research investments should be pursued that can demonstrate a capital and/or operating improvement that will allow the displacement of oil on a cost-competitive basis, including a reasonable return on capital. Research in the following areas within the conversion sector will help to address barriers.

Pretreatment:

Pretreatment technologies need improvement to provide efficient conversion of the feedstock into a higher concentration of sugars derived from a process with relatively low capital costs and to minimize degradation of sugars and create inhibitory byproducts.

Fermentation:

Capital costs for industrial fermentation of structural carbohydrates are excessive relative to capital costs for first-generation ethanol, biodiesel, and petrochemically derived chemicals. Fermentation needs to be viable in low-cost simple tanks with minimal aeration instead of highly specialized fermentation vessels.

Organisms need further improvement to handle a wider variety of feedstock hydrolysates, to utilize a variety of sugar types (i.e., glucose, sucrose, xylose, arabinose, etc.), and to be more robust to impurities in the hydrolysate.

Thermochemical Catalysis:

Compared to the knowledge that exists for converting petrochemical feedstocks, there is not a solid understanding of catalytic conversion of biomass feedstocks. There is a lack of knowledge about how reactions occur on the surface of catalysts and how to limit the fouling and deactivation caused by impurities—regardless of whether the catalysis is based on deoxygenation, hydrogenation, hydrogenolysis, decarbonylation, or other chemistries. Biomass conversion systems are also more complex because of the predominance of water in the process systems. The attraction of these processes is that lignin can be utilized in addition to other feedstock components. There is warrant for expanded research to better link biomass processing with petrochemical processing.

Separations:

Separation processes are particularly difficult and costly because of the high amounts of water involved in biomass systems. Product concentrations in the hydrolysate are often lower than in petroleum systems. There is a need to develop new membrane technologies, novel molecular recognition systems, or other recovery strategies to significantly reduce capital and operating costs.

C. Market Incentives, Updated Distribution Infrastructure, and Consumer Adoption

The major barrier of translating new biomass technologies to the marketplace is the absence of a reliable and sufficient market price for the fuel products. Traditional fuel prices are based on the market price of petroleum, which currently is 3–10 times its cost of production. Because crude oil producers have room to cut prices and remain profitable, today's fuel price is a "moving target." The result is a volatile market dynamic for biofuels that renders the new industry uncompetitive.

<u>Potential Solutions</u>:

Market Incentives:

From a non-technical perspective, there is a need to make long-term commitments to policies to encourage use of renewable materials for the production of both biofuels and biochemicals. The capital markets require confidence that the policy will be in place long enough to ensure reasonable return on capital investments.

Distribution Infrastructure:

Recent advancements in biomass conversion technologies must be directed at accessing established feedstocks. Bench scale is needed to establish robust conversion technologies prior to deploying these technologies at large scale. From an engineering perspective, integrating unit operations is a challenge, especially since the scaling factor of one unit is substantially different. It is common to see a limit to unit size of biological operations that is different from the scalability of machinery. New early stage R&D can facilitate creation of new unit operation modules, but latter stage development must address integration of all elements of the process. Early stage R&D will need clear and compelling logic and analysis to elucidate how each part will successfully integrate into a whole process.

The intermediate infrastructure between feedstock production and conversion processing is widely recognized as an essential element of the value chain. This essential infrastructure must create value for both the upstream feedstock element and the downstream conversion sector. In order to better utilize low-cost waste streams, logistics and conversion processes need to become more robust in order to handle the diversity that is inherent to biomass feedstocks. Specific needs include the following:

- Matching of the most appropriate conversion technologies to available amounts of waste streams
- Limited research on preprocessing of waste materials
- Inefficient handling of MSW
- Feedstock specifications by conversion facilities are not standardized
- Reticence on the part of concerned citizens over the change in use of waste streams and the conversion processes in which they will be used.

IX. Public Comment

None.

X. Closing Comments

Meeting was adjourned.

Attachment A: Committee Member Attendance—November 21–22, 2013

Co- Chairs	Affiliation	Attended?
Ronnie Musgrove	Former Governor, MS	Yes
Kevin Kephart	South Dakota State University	Yes

Members	Affiliation	Attended?
Dean Benjamin	NewPage Corporation	Yes
David Bransby	Auburn University	No
Paul Bryan	UC-Berkeley	Yes
Pamela Reilly Contag	Cygnet Biofuels	Yes
Steve Csonka	Commercial Aviation Alt. Fuels Initiative	Yes
Harrison Dillon	Solazyme	Yes
Claus Crone Fuglsang	Novozymes North America, Inc.	No
Neal Gutterson	Mendel Biotechnology	No
Huey-Min Hwang	Jackson State University	No
Joseph James	Agri-Tech Producers, LLC	Yes
Coleman Jones	General Motors	Yes
Craig Kvien	University of Georgia	Yes
Kit Lau	BioAmber Inc.	Yes
Johannes Lehmann	Cornell University	No
Jay Levenstein	FL Dept. of Ag. and Consumer Services	No
Stephen Long	University of Illinois	No
Maureen McCann	Purdue University	Yes
Bruce McCarl	Texas A&M	Yes
Christine McKiernan	BIOFerm Energy Systems	Yes
Ray Miller	Michigan State University	Yes
Neil Murphy	State University of New York,	Yes
David Nothmann	Battelle	Yes
Jimmie Powell	The Nature Conservancy	No
William Provine	Dupont	Yes
James Seiber	University of California	Yes
Abolghasem Shahbazi	North Carolina A&T State University	Yes
Don Stevens	Cascade Science and Tech. Research	Yes
John Tao	O-Innovation Advisors LLC	Yes
Alan Weber	MARC-IV Consulting / Weber Farms	Yes
Todd Werpy	Archer Daniels Midland Company	No

Total: 23 of 32 members attended

Attachment B: Agenda—November 21–22, 2013

Day 1: Technical Advisory Committee Meeting **November 21, 2013**

8:00 a.m. – 8:30 a.m.	*Breakfast (to be provided for Committee)* *Room A*
8:30 a.m. – 8:40 a.m.	Welcome Committee Co-Chairs
8:40 a.m. – 9:10 a.m.	Presentation: Committee Business and DOE Updates *Elliott Levine, DFO, Bioenergy Technologies Office, U.S. Department of Energy*
9:10 a.m. – 9:25 a.m. Office Manager	Presentation: Introduction of New Bioenergy Technologies *Jonathan Male, Director, Bioenergy Technologies Office, U.S. Department of Energy*
9:25 a.m. – 10:25 a.m.	Presentation: Results of the Bioenergy Technologies Office Peer Review ○ *George Parks, President, FuelScience LLC* ○ *Jonathan Male, Director, Bioenergy Technologies Office, U.S. Department of Energy*
10:25 a.m. – 10:40 a.m.	*Break*
10:40 a.m. – 11:00 a.m.	Presentation: USDA Update on Biomass R&D Activities *Todd Campbell, U.S. Department of Agriculture*
11:00 a.m. – 12:00 p.m.	Breakout: Subcommittees
12:00 p.m. – 1:00 p.m.	*Lunch (to be provided for Committee)*
1:00 p.m. – 1:15 p.m.	Public Comment
1:15 p.m. – 5:30 p.m.	Discussion: Subcommittee Theme Reports and Discussion of Recommendations

<u>Day 2: Technical Advisory Committee Meeting   November 22, 2013</u>

8:00 a.m. – 8:30 a.m.	*Breakfast (to be provided for Committee)* *Room A*
8:30 a.m. – 10:00 a.m.	<u>Panel</u>: Use of Marginal Lands for Bioenergy ○ *Solutions from the Land, Ernest Shea, Project Coordinator, Solutions from the Land Dialogue* ○ *Sustainable Bioenergy Production from Marginal Lands in the U.S. Midwest, Dr. Csar Izaurralde, Joint Global Change Research Institute*
10:00 a.m. – 11:00 a.m.	<u>Discussion</u>: Subcommittee Theme Reports and Discussion of Recommendations
11:00 a.m. – 11:15 a.m.	<u>Vote</u>: 2013 Annual Recommendations
11:15 a.m. – 11:30 a.m.	<u>Public Comment</u>
11:30 a.m. – 12:00 p.m.	<u>Closing Comments</u>: *Departing Committee Members*
12:00 p.m. – 1:00 p.m.	*Lunch*
1:00 p.m.	Adjourn